EXPERIMENR 01

AIM:- Plot Plank's law for black body radiation and compare it with Raleigh- jeans law at high temperature and low temperature .

THEORY :-

1.Plank's radiation law :- Wien displacement law and Rayleigh jeans formula could not explain the entire shape of the cures giving the energy distribution in black body radiation . To explain the entire shape, plank in the beginning imagined that a black radiation chamber is filled up not only with radiation but also with the molecules of a perfect gas . Planck gave anew revolutionary idea which laid the foundation of the modern quantum theory. udr = $8\pi hc * drr5 \exp(hc) - 1\ rkt$ 2. Rayleigh jeans law:- The deduction of Rayleigh law for the distribution of energy in the normal spectrum has been done by assuming of that the energy is equally dividedamong all the possible motes of vibration.udr = $8\pi rkt\ dr$ 4

Algorithm :-

1. Start the Sci lab software and write the all given input values of constant h, k, c, etc.
2. Gives the different values of temp. in Kelvin .
3. Using the linspace command for define the range .
4. Using the for loop for discrete the no. of particle.
5. Give the for loop for temperature.
6. Write the equation of plank ,Rayleigh and Wien's law.
7. Using the subplot command and plot the graph of plank , Rayleigh And comparing between the plank and Rayleigh law.

8. And finally comparing between the plank ,Rayleigh and weins law.
9. Using the legend command for comment on graph and using xgrid command .

Programe:-

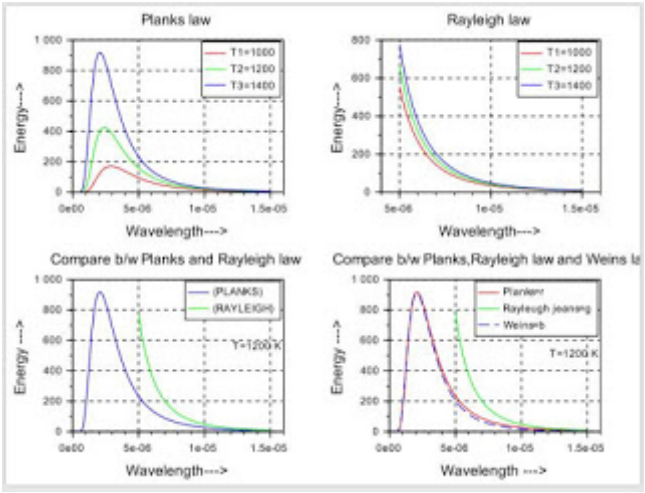
```
clc
clf
h=6.626e-34 //planks constant k=1.38e-23 //boltzmann constant c=3e8 //speed of light t=[1000,1200,1400] //temp (KELVIN) n=1400
r=linspace(0.1e-6,15e-6,n) r0=linspace(5e-6,15e-6,n) for i=1:n
for j=1:3 u(j,i)=(8*%pi*h*c)/((r(i))^5*(exp(h*c/(r(i)k*t(j)))-1)) m(j,i)=(8%pi*k*t(j))/(r0(i))^4 v(j,i)=(8* %pi*h*c)/((r(i))^5*(exp(h*c/(r(i)*k*t(j)))))
end
end
subplot(2,2,1)
plot(r,u(1,:),'r')
plot(r,u(2,:),'g')
plot(r,u(3,:),'b') xlabel("Wavelength--->","fontsize",3) ylabel("Energy--->","fontsize",3) title("Planks law","fontsize",3) legend("T1=1000","T2=1200","T3=1400") xgrid
subplot(2,2,2)
plot(r0,m(1,:),'r')
plot(r0,m(2,:),'g')
plot(r0,m(3,:),'b') xlabel("Wavelength--->","fontsize",3) ylabel("Energy--->","fontsize",3) title("Rayleigh law","fontsize",3) legend("T1=1000","T2=1200","T3=1400") xgrid
subplot(2,2,3) plot(r,u(3,:),'b') plot(r0,m(3,:),'g')

xlabel("Wavelength--->","fontsize",3)
ylabel("Energy --->","fontsize",3)
```

title("Compare b/w Planks and Rayleigh law","fontsize",3) legend("(PLANKS)","(RAYLEIGH)")
xstring(1.2e-05,500,"T=1200 K")
xgrid
subplot(2,2,4)
plot(r,u(3,:),'r')
plot(r0,m(3,:),'g')
plot(r,v(3,:),'b--')
xlabel("Wavelength --->","fontsize",3)
ylabel("Energy --->","fontsize",3)
title("Compare b/w Planks,Rayleigh law and Weins law ","fontsize",3) legend("Planks=r","Rayleugh jeans=g","Weins=b") xstring(1.2e-05,450,"T=1200 K")
xgrid

Results:-

1. Rayleigh jeans used classical physics to explain black body Spectrum .This law hold good at higher wavelength but is in complete disagreement with experimental data, for shorter wavelength .This is failure is k/a UV catastrophe because energy density tends to infinity after visible region or in UV region.
2. The plank's law fully explain the black body Spectrum, be used the Concept of quantum mechanics. That the energy exchanged b/w the radiation and matter is not continuous indeed it is discrete.
3. Wien's law is in good agreement with the experimental result for shorter wavelength but it deviates for longer wavelength.



EXPERIMENR 02

Programme : Plot specific heat of solids Dulong-Petit Law Einstein Distribution function Debye distribution function for high temperature and low temperature and compare them for these two cases. For copper Debye temperature is 345 K plot plot Cv VS T graph for Dulong-Petit law, Einstein law and Debye law. Find range of temperature at which Einstein and Debye law approaches Dulong Petit law. For Diamond ^{0}D = 2100 K, plot the variation of specific heat at low temperature

Formula used and Theory

CV = 3R

CV = (3R (hv/KT)2 exp (hv/KT))(exp(hv/KT)-1)2
CV = (9R (T/^{0}D)3 (X4exdx)/(ex-1)2
Here R = Universal Gas Constant (Joule mol / Kelvin)
h = Plank's constant
K = Boltzmann's constant
T = Temperature
^{0}D = Debye Temperature

Algorithm

Input all the values of constants such as of R, h, ^{0}D, KB etc.
Now define an array for temperature ranges such that t=linspace(1,3000,1000).
Now define the function for
Now, plot the different curves using plot command.
Label the graph using commands such as xlabel, ylabel, title, legend etc.

Coding

```
scf
clc
clf()
clear
r=8.314
h=6.626e-34
K=1.38e-23
thetaD=345 //EINSTEIN temperature
v=(K*thetaD/(h))
t=linspace(1,3000,1000)
function y=Cv1(t)
    y=3*r //Dulong petit law
endfunction
for i=1:1000
    Cv2(i)=3*r*(h*v/(K*t(i)))^2*(exp(h*v/(K*t(i)))/((exp(h*v/(K*t(i))))-1)^2)          //Einstein Law
end
plot(t,Cv1,'g*')
plot(t,Cv2,'b*')
t1=linspace(1,3000,1000)
function y1=f(x)
    y1=(((x.^4)*(exp(x)))/((exp(x)-1).^2))
endfunction
i=1
for T=1:1:3000
z(i)=T
x(i)=(h*v)/(K*T)
y(i)=9*r*((T/thetaD).^3)*(intg(0,(thetaD/T),f))
i=i+1
end
plot(z,y)
title('specific heat V/s temperature for Dulong Petit, Einstein Law and Debye Law','fontsize',5)
xlabel('Temperature(Kelvin)','fontsize',5)
ylabel('Specific Heat','fontsize',5)
xgrid()
```

```
scf
clc
clf()
clear
r=8.314
h=6.626e-34
K=1.38e-23
thetaD=2100              //EINSTEIN temperature
v=(K*thetaD/(h))
t=linspace(1,500,100)
function y=Cv1(t)
   y=3*r              //Dulong petit law
endfunction
for i=1:100
   Cv2(i)=3*r*((h*v/(K*t(i)))^2)*(exp(-(h*v/(K*t(i)))))          //Einstein Law
end
plot(t,Cv1,'g*')
plot(t,Cv2,'b*')
thetaD1=2100             //DEBYE temperature
T=linspace(1,500,100)
for i=1:100
   Cv(i)=(12/5)*(%pi).^4*r*(T(i)/thetaD1)^3
end
plot(T,Cv)
title('specific heat V/s temperature for Dulong Petit, Einstein Law and Debye Law','fontsize',5)
xlabel('Temperature(Kelvin)','fontsize',5)
ylabel('Specific Heat','fontsize',5)
xgrid()
```

Result

According to Dulong Petit law the molar specific heat capacity at constant volume is given by Cv=3R=24.9 J / mol K
According to Einstein's theory each atom vibrates with same angular frequency wE and may be treated as an independent oscillator. It means that all 3 Na modes of oscillation of a solid have the same frequency.
According to Debye theory molar specific heat capacity of solid is given by
$CV = 3R[12 (T/{}^{0}D)3 (X3dx)/(ex-1))-3({}^{0}D/T)/(exp({}^{0}D/T)-1)]$
The term within the square bracket is termed as the Debye function
At high temperature $T>>{}^{0}D$
So $exp({}^{0}D/T)-1 = exp({}^{0}D/T)$
Hence integration reduces to
$(X3dx)/(ex-1)) = (X2dx) = (1/3)({}^{0}D/T)3$
And the second term becomes equal to 3. This means at high temp the Debye function becomes unity and Cv=3R.

EXPERIMENR 03
Plot the following functions with the energy at different temperatures a) Maxwell-Boltzmann distributionb) Fermi-Dirac distributionc) Bose-Einstein distributiond) And compare all the three distributions for 100 Kelvin

Theory:-

1.Bose- Einstein statistics:- In case off Bose- particles are indistinguishable . So the interchange of two particle between two energy states will not produce any new state.

$n(i)$ = g(i)/(exp{α + βε(i)} − 1)

2. Fermi-Dirac statistics:- In case of Fermi- Dirac Statistics applicable to particles like electrons and obeying Pauli exclusion principle , only one particle can occupy a single energy state.

$n(i)$ = g(i)/(exp{α + βε(i)} + 1)

3. Maxwell-Boltzmann statistics:- The conditions in Maxwell- Boltzmann statistics are- (i) Particles are distinguishable i.e. there are no symmetry restrictions .

(ii) Each Eigen state Ith quantum group may Contain 0,1,2,3.....n particles.

(iii) The total number of particles in the entire system is always constant i.e. n= n1+n2 +.....ni=∑ni = constant.

(iv) The sum of energies of all the particles in different quantum groups , taken together, constitutes the total energy of the system.

$n(i)$ = g(i) /exp{α + βε(i)}

Algorithm – for u=kt –

1. Given the value of constant K and T .
2. Write the equation of U= KT .
3.Using the linespace command for define the range.
4.Using the for loop and write the equation of Fermi, Bose and Maxwell's equation. 5. Using the subplot command and plot the graph of Fermi, Bose and Maxwell's.
6. Leveling the level and title on the graph and using the legend command.

For u=o:-

1. Write the value of 'K' for different Statistics .
2. Gives the different temperature [T1, T2,T3,T4] .
3. Write the equation of U=0 .
4. Using the ' linspace command' for define the range the range and for loop .
5. Write the equation of Maxwell-Boltzmann ,Fermi Dirac and Bose Einstein of different temperature [T1,T2,T3,T4] .
6. Using the subplot command and plot the graph of Maxwell ,Fermi and Bose Statistics of different temperature .
7. Leveling the level and title on the graph and using the legend command and xgrid command .

Program:- 2(a)

```
clc
clf
k=8.617e-5
t=100
u=k*t
b=1/u; r=linspace(0.01,5*u,100)' for i=1:100
f(i)=1/(exp(b*(r(i)-u))+1) e(i)=1/(exp(b*(r(i)-u))-1) v(i)=1/exp(b*(r(i)-u))
end
subplot(2,2,1)
plot(r,f,'r')
plot(r,e,'g')
plot(r,v,'b')
xlabel('Energy--->>','fontsize',3)
ylabel('occupation number'--->>','fontsize',3)
title('occupation number' v/s Energy for maxwell,bose and fermi statistics','fontsize',3)
```

Program:-2(b)

```
clc
clf
K1=0; //Maxwell-Boltzmann Statistics K2=1; //Fermi-Dirac Statistics K3=-1; //Bose-Einstien Statistics T1=1;
T2=5;
T3=10;
T4=20;
```

```
u=0;
x=linspace(1,50,100);
for i=1:100 v1(i)=1/(exp(x(i)/T1)+K1); v2(i)=1/(exp(x(i)/T2)+K1); v3(i)=1/(exp(x(i)/T3)+K1);
v4(i)=1/(exp(x(i)/T4)+K1);
end
subplot(2,2,1)
plot(x,v1,'c')
plot(x,v2,'b')

plot(x,v3,'g')
plot(x,v4,'k')
xgrid
legend(['T1';'T2';'T3';'T4'])
xlabel('Energy','fontsize',3)
ylabel('occupation number'','fontsize',3)
title('occupation number' v/s Energy for M-B Statistics','fontsize',3)
y=linspace(-50,50,100);
for i=1:100 w1(i)=1/(exp(y(i)/T1)+K2); w2(i)=1/(exp(y(i)/T2)+K2); w3(i)=1/(exp(y(i)/T3)+K2);
w4(i)=1/(exp(y(i)/T4)+K2); end
subplot(2,2,2)
plot(y,w1,'c')
plot(y,w2,'b')
plot(y,w3,'g')
plot(y,w4,'k')
xgrid
legend(['T1';'T2';'T3';'T4'])
xlabel('Energy','fontsize',3)
ylabel('occupation number'','fontsize',3)
title('occupation number' v/s Energy for F-D Statistics','fontsize',3)
x=linspace(1,50,100);
for i=1:100 m1(i)=1/(exp(x(i)/T1)+K3); m2(i)=1/(exp(x(i)/T2)+K3); m3(i)=1/(exp(x(i)/T3)+K3);
m4(i)=1/(exp(x(i)/T4)+K3); end
subplot(2,2,3)
plot(x,m1,'c')
plot(x,m2,'b')
plot(x,m3,'g')
plot(x,m4,'k')
xgrid
legend(['T1';'T2';'T3';'T4'])
xlabel('Energy','fontsize',3)
ylabel('occupation number','fontsize',3)
title('occupation number v/s Energy for B-E Statistic','fontsize',3)
```